A DUAL RADIATOR RICH DETECTOR FOR THE HERMES EXPERIMENT

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The HERMES experiment uses the polarised electron or positron beam of the HERA accelerator in conjunction with polarised internal gas targets to study the spin structure of the nucleon. A ring imaging Čerenkov (RICH) detector with a dual aerogel-gas radiator has been installed to allow the identification of pions, kaons and protons over practically the entire momentum range of HERMES (2-16 GeV). The Čerenkov rings are detected by two arrays of 1934 photomultiplier tubes which are read out digitally with a LeCroy PCOS4 system. The first HERMES data including the new RICH have been taken in August 1998 and the first rings have been observed in the detector.

1 The HERMES Experiment

The HERMES experiment[1] uses the 27.5 GeV beam of polarised electrons or positrons provided by the HERA accelerator in conjunction with polarised internal gas targets to investigate the spin structure of proton and neutron. The scattered lepton is identified with excellent efficiency and very low contamination through the combination of an electromagnetic calorimeter, a preshower detector and a transition radiation detector. Leading hadrons that are detected and identified in coincidence with the scattered lepton can be used to identify the struck parton. This flavour tagging method in combination with the use of different target gases allows to separate the contributions of the quark flavours to the spin of the nucleon. For complete hadron identification a ring imaging Čerenkov (RICH) detector with a dual aerogel-gas radiator has recently been installed in the HERMES experiment, replacing the threshold Čerenkov detector that was used through 1995-97. As the HERMES spectrometer consists of two identical halves, two identical RICH detectors ('top' and 'bottom') had to be built.

2 Design of the RICH Detector

Three main requirements had to be taken into account in the design of the RICH detector. Firstly, a radiator had to be found that covers the momentum range of the experiment, especially the low momentum region. Secondly, the new detector had to fit into the limited space defined by the size of the former threshold Čerenkov detector, and finally to maintain the excellent tracking capabilities of the HERMES spectrometer the material added by the RICH needed to be thin in terms of radiation lengths. Due to the second and third requirement highly pressurized gas was not an option. However, recently a clear, hydrophobic aerogel has become available, an ideal radiator for the low momentum region. Hence the first requirement could be fulfilled by not using one, but two radiators: aerogel (n=1.03) and C_4F_{10} gas (n=1.0014). By using the detector housing of the former threshold Čerenkov detector as gas volume for the RICH and by fabricating the mirror from a carbon fibre material the other two requirements could be fulfilled.

The aerogel radiator consists of tiles, $11 \times 11 \times 1$ cm^3 each, in stacks of five tiles, ordered in 5 rows and 17 columns per detector. The stacks are separated from one another by black tedlar sheets to absorb scattered and internally reflected light. The downstream cover plate of the aerogel container is made of 3.2 mm lucite which due to its UV absorption reduces the amount of Rayleigh scattered light by about a factor of two. The hydrophobic aerogel produced by Matsushita Co.[a] has an index of refraction of 1.0304 ± 0.0004 and a transmittance of 67.5 % at 400 nm.

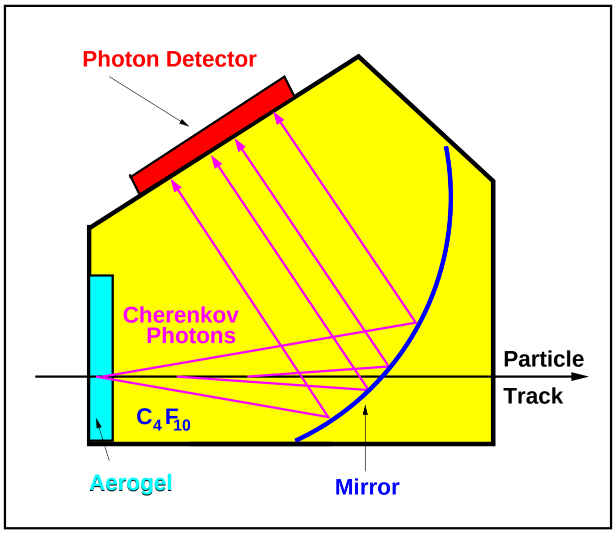

Figure 1: Schematic side view of the top rich detector.

[a]Matsushita Electric Works, Ltd., Central Research Laboratory, 1048 Kadoma, Osaka 571, Japan

The Čerenkov photons from both radiators are reflected onto a PMT matrix made of 1934 PMTs (Philips XP1911/UV green enhanced) arranged as hexagonal grid. The use of reflective funnel cones at the PMT front-ends increases the effective sensitive surface to 92% of the matrix area. The PMTs were chosen for the readout, because their quantum efficiency as a function of wavelength is well matched to the emission spectrum of Cerenkov light from the aerogel, and due to their good ratio of sensitive to insensitive surface area. The PMT matrix is readout digitally using a LeCroy PCOS4 system. Figure 1 shows a schematic side view of the top RICH detector.

3 Status of the RICH

The HERMES RICH detector was built by the HERMES RICH group[b] in one year from concept approval to completed installation. It is the first detector to use clear, hydrophobic aerogel as a Čerenkov radiator in a RICH system. Data taking has started in August 1998 and the first rings in the detector have been observed shortly thereafter. The observed background is of the order of one firing PMT per detector half in five events. Figure 2 shows the a typical hit patterns with (inner) gas and (outer) aerogel ring..

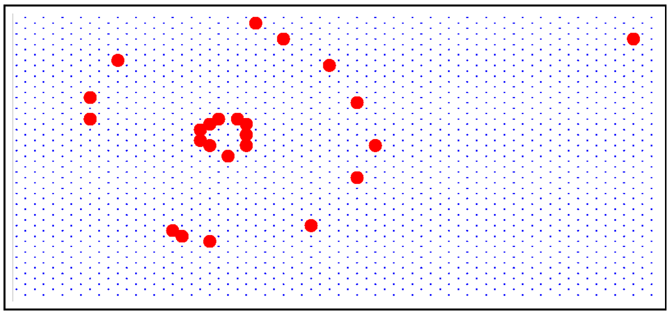

Figure 2: Hit pattern for a 4.4 GeV π^+ in the bottom RICH detector. Gas and aerogel ring are clearly visible. Run 915, Event 17808872.

References

1. K.Ackerstaff *et al*, DESY 98-057, hep-ex/9806008 (1998), *Nucl. Instrum. Methods* **A** (in press).
2. E.Cisbani *et al, 'Proposal for a Dual Radiator RICH at HERMES',* HERMES Internal Note 97-003, `http://www-hermes.desy.de/notes/pub/97-LIB/jackson.ps.gz`

[b] Argonne, Bari, Caltech, Frascati, Gent, Rome-Sanita, Tokyo, Zeuthen